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PROVISIONAL SPECIFICATION.

Improvements in the Manufacture of Beer.

A communication from abroad from ALPHONSE ANTREAUME, of Lille, Dept. du Nord, France, Manufacturing Chemist.

I, WILLIAM LLOYD WISE of 46 Lincoln's Inn Fields in the County of London, Consulting Engineer and Chartered Patent Agent, do hereby declare the nature of this invention to be as follows :—

This invention has reference to improvements in the manufacture of beer and consists in a succession of operations and reactions hereinafter described.

The raw grain is brought by any suitable conveying apparatus to a bolting mill or grain cleaning device cord separator or sifter whereby it is cleaned. From this apparatus, the raw grain may advantageously be passed into a washer in which it is steeped in slightly acidulated water under a pressure of one atmosphere, this steeping process allowing of the grain becoming very rapidly penetrated. By means of an energetic washing operation it is then freed from soluble and other matters or impurities the presence of which is useless and injurious to the subsequent operations, and to the obtaining of a good final result.

The grain thus steeped and washed is conveyed by any suitable means as for example by an Archimedean screw into the cooker, into which has been previously introduced a weight of water equal to one or one and a half times the weight of the grain; this water should be acidulated with tartaric acid if the grain has not been submitted to the steeping operation above referred to. A jet of steam at a pressure of three atmospheres is then introduced into the mass so as to bring the same up to a temperature of from about 130 to 135° C. The duration of this operation varies from between two to three hours according to the nature of the grain. The apparatus for effecting this wet cooking is provided with a cock by means of which there is admitted into the mass a continuous jet of steam which removes unpleasant odours and the essential and empyreumatic oils, whilst at the same time producing in the interior of the apparatus a continual stirring of the mass which prevents the starch paste from adhering to the walls of the apparatus. By thus cooking at a high temperature, there is obtained the burnt sugar taste or flavor which is usually imparted by kiln-drying in the ordinary way, and which imparts to the beer the esteemed properties of softness and fineness by the conversion, by means of hydrolysis, of the gummy substances into peptones and into amides.

It is advisable to arrest the cooking operation when the liquefaction of the starch is sufficiently advanced and its conversion into starch paste has been effected. The cooked grain on passing from the wet cooking apparatus, is received into the mash-tun where it is subjected to the operation of mashing in the presence of green malt that has been rendered milky, and of the grains of green malt.

The green malt is rendered milky in the following manner :—

The malt coming directly from the germinator is passed into a kneading crusher, and thence into a receiver provided with a mechanical agitator where it is mixed with a definite quantity of water. This operation is effected at a low temperature and just before it is desired to use the product, the liquid portion of the milk of malt, passed through a sieve, being collected with care in a vessel designed for the purpose.

The grains of green malt and a portion of the clear milk of malt are introduced into the mash-tun only when the temperature of the mass therein has become sufficiently lowered say from 65° to 70° C. to allow of a suitable dextrination of the starch under the action of the diastase of the green malt.

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The mashing of the mixture of starch paste, the grains of green malt, and filtered or strained milk of green malt, is effected quickly or energetically, and the contents of the mash tun are allowed to remain at rest and may be covered. The dextrination-saccharification is effected in from about one hour to an hour and a half at a temperature of 60—65° centigrade. This completes the first steeping 5 operation.

The liquid thus obtained is drawn off, its first cloudy portions being drawn off separately and returned to the mash-tun. The clear liquid is drawn off into the under-back whence it is conveyed to the saccharification copper.

This being done, the second steeping is now proceeded with. For this purpose 10 hot water is passed into the mash-tun and the mixture is raised to a temperature of from about 65 to 68° C., the mashing operation being effected anew with a fresh addition of milk of green malt. The mash-tun is then covered up and allowed to rest for half an hour; and the clear liquid is drawn off as in the case of the first steeping and is added to the clear liquid first drawn off. 15

In order to completely exhaust the grain contained in the mash-tun, a third operation, under the same conditions, may be effected if necessary.

The residue or malt waste (spent grains) serves for feeding cattle.

The liquor in the saccharification copper, which is furnished with a hot and cold water coil and with a slowly moving mechanical agitator, is raised to the tempera- 20 ture of from about 50 to 55° C. The remainder of the clear or filtered portion of the milk of green malt is introduced into the saccharification copper and the mass is agitated during from about one hour to an hour and a half according to the indication given by tincture of iodine.

By the method of manufacture hereinbefore set forth, the brewer is enabled to 25 prepare in a methodical manner, the worts suitable for the kind of beer he wishes to produce, according to the respective proportions of sugar and dextrine which he desires to pass into the said worts and which determine the character of the beer produced. For this purpose it is merely necessary to suitably vary the durations and the temperatures of the two operations of dextrination and of saccharification, 30 and to modify the proportions employed of the milk of green malt. In order to produce beers rich in alcohol, the saccharification should be pushed to its maximum reserving for this operation, which takes place at 50—55° C. a larger proportion of the milk of malt. Whereas on the contrary to produce beers rich in extract, dextrination should be favoured by operating in the mash-tun, at a temperature of 35 from about 68 to 72° C., with a larger proportion of milk of malt, and finally, the method of high or low fermentation will complete the preparation of the liquid.

After the saccharification is terminated, the wort is brought to ebullition, and is subjected in the saccharification copper to oxygenation during half an hour.

The wort is then passed through a press filter or any other suitable filtering 40 apparatus and if, before this last operation, it be considered necessary for the preparation of certain beers, the wort can be subjected in the same saccharification copper, at a temperature of 30 to 35° C. to a special clarification. In view of this operation, the saccharification copper should be provided with a cock and with a discharging bung hole. The clarification may also be effected in a special copper, 45 termed a "clarification copper."

After filtering the liquor is passed into the cooking copper where hops are put into it, and it is brought to the desired degree of concentration according to the kind of beer it is intended to produce, as well understood. The duration of the cooking varies with the degree of concentration to be obtained. 50

The wort is then submitted to a rapid cooling until the degree of temperature is obtained which is suitable for the method of fermentation adopted in the brewery in which the operations are carried on. After cooling, the wort is passed into the working or fermenting tun and the ordinary operation of fermentation followed.

The process hereinbefore described allows of the production of beer under 55 excellent conditions, using only raw grain and causing it to yield all its contained starch. The green malt is employed only with a view to provide diastase for use

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as a dextrinating and saccharizing agent. The proportion of green malt employed is only about 10 % of the weight of the raw grain, thereby diminishing to a very considerable extent the usual malting operation, and obviating kiln drying of the malt.

- 5 The dextrination and saccharification may also be effected by means of the flour of dry malt; and also by the use of acids (mineral acids, such as sulphuric acid hydrochloric acid, *etc.* and organic acids, particularly oxalic acid) thereby entirely dispensing with the use of malt. In the foregoing description mention has been made of raw grain only; it is obvious that barley and all amylaceous products, 10 such as wheat rice, maize, potatoes *etc.* can be utilized in the same manner for manufacturing beers according to this invention.

Dated this 26th day of February 1892.

W. LLOYD WISE,
Per F. J. Brougham.

COMPLETE SPECIFICATION.

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Improvements in the Manufacture of Beer.

A communication from abroad from ALPHONSE ANTREAUME, of Lille, Dept. du Nord, France, Manufacturing Chemist.

- I, WILLIAM LLOYD WISE of 46 Lincoln's Inn Fields in the County of London, 20 Consulting Engineer and Chartered Patent Agent, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement :—

This invention has reference to improvements in the manufacture of beer and consists in a series of operations and reactions hereinafter described.

- 25 The raw grain is brought by any suitable conveying apparatus to a bolting mill or a grain cleaning device, and is then passed to a separator or sifter provided with brushes having a variable pressure.

- From this apparatus, the raw grain may advantageously be passed into a grain washing device or cylinder the lower part of which is of conical form and furnished 30 with valves for discharging water. A preliminary washing operation is effected by causing the water to enter at the lower part of the cylinder and traverse the mass of grain with a great speed in order to carry off a portion of the impurities which the said mass may contain. After this has been done, there is introduced into the top of the washing cylinder about 100 litres of clean fresh water per 35 100 kilogs., of grain, and by means of an air pump, the mass is subjected to a pressure of about one and a half atmospheres. Under the action of this pressure, the grain is quickly penetrated by the water, swelling takes place and as the envelope has then no longer any folds, the energetic washing process to which it is afterwards subjected is perfect. The steeping takes from about 1½ to 40 2 hours. In order to proceed with the washing, the steeping water is discharged, a current of pure water is supplied to the grain washing cylinder, and the mechanical agitator with which the apparatus is furnished, is set in motion. Inclined paddles beat vigorously the already steeped and swelled grain and the last impurities are carried off.

- 45 The grain thus steeped and washed is conveyed by any suitable means such as an Archimedean screw into a grain cooking apparatus into which has been previously introduced a weight of water equal to about two or three times the weight of the grain, the temperature of the water introduced being from about 50 to 60° C. Steam at a pressure of from about two and a half to three atmospheres is then 50 introduced into the mass so as to bring the same to a temperature of about 128 to 135° C. The duration of this operation usually varies between from about forty minutes to one hour, according to the kind of grain treated.

The grain cooking apparatus is provided with a safety valve and has at its upper part a cock by means of which a continuous jet of steam can be allowed to escape

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for removing or disengaging the bad odours, and essential and empyreumatic oils *etc.* evolved whilst causing in the interior of the apparatus a continual agitation of the mass which facilitates the formation of starchy paste. The principle of this cooking under pressure consists in subjecting each particle of starch to the action of the steam in the cooker, in order that each grain shall undergo the swelling 5 necessary for its conversion into starch paste so as to ensure a good saccharification during its subsequent treatment.

Furthermore there is obtained by this cooking of the grain at a high temperature, the burnt sugar taste or flavour which is usually imparted by kiln-drying at a high temperature in ordinary working, and the beers produced from grain thus treated 10 have imparted to them the esteemed properties of softness and fineness by the conversion, by means of hydrolysis, of the gummy substances into peptones and into amides.

It is advisable to arrest the cooking operation when the starch paste is well formed. This point can be determined by microscopic or other tests of samples 15 withdrawn from time to time. The cooked mass on leaving the cooking apparatus, is received into the mash-tun in order to undergo the operation of brewing in the presence of a certain quantity of green malt that has been rendered milky, and to allow, after saccharification, of the separation of the liquid portion from the solid substances (waste grains). 20

In order to increase the number of points of action of the diastase on the starch paste and in order to render its action effective, the green malt, before being introduced, is made to pass into a special crushing device and rendered milky. The crushing device is composed of smooth juxtaposed cylinders capable of being moved away from or nearer to one another. The cylinders should either be of different 25 diameters, and make the same number of revolutions in a given time, or be of the same diameter and made to run at different speeds so that the malt undergoes not only a crushing action but also a tearing action by reason of which its comminution is rendered complete. The malt thus crushed is received into a vat provided with agitators supported by a vertical shaft and acting throughout the entire height of 30 the mass. To this vat there is added the necessary quantity of water, say about 4 to 6 litres per kilog. of malt treated, the temperature of the water being about 15 to 16° C.

After an agitation of about half an hour the solution is passed on to a close meshed sieve; the clear portion is received into a special receiver provided with a 35 graduated level-tube and with a pipe for conveying the milk of malt to the mash-tun. The solid portion, that is to say, the waste grains, and the thick portion are collected separately. The mass received into the mash-tun on leaving the cooker, is brought rapidly, whilst being agitated by means of the agitator with which the tun is provided, to a temperature of about 80° C.; and then the waste grains of the 40 thick portion of the milk of malt are poured into the mash tun whilst continuing the agitation. The object of making this first pouring at a high temperature is to liquefy the starch which may be contained in the grains and in the thick portion of the milk of malt, and to convert it into starch paste.

When the temperature has sunk to 70—72° C., about one half of the clear and 45 sieved portion of the milk of malt is poured into the mash-tun.

The brewing of the mixture is effected vigorously during say about half an hour, and the said mixture then allowed to rest during say another half hour the mash-tun being covered in order to avoid all loss of heat.

The mash-tun should have certain special arrangements to enable the process of 50 manufacture to be carried out. Thus the distance from the bottom to the false bottom should be very much reduced; the mechanical agitator should extend almost to the level of the false bottom; it may even be advisable to provide the lower arms with paddles of rubber; and a pump should be provided to allow of returning above the mass contained in the mash-tun, the liquid which is enclosed 55 between the two bottoms and which is not in direct contact with the material that is undergoing the brewing process. It is indispensable that the mash-tun should

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be provided with a heating device for enabling the temperature of the mass which it contains to be rapidly raised by means of steam.

The starch paste on leaving the cooker, might by contact with the false bottom of the mash-tun become suddenly cooled and by becoming solidified obstruct the
5 holes in said false bottom and thus prevent or hinder the discharge of the liquid when filtering the same. For the purpose of obviating this disadvantage, there is introduced into the mash-tun before discharging the cooker, a certain quantity of hot water at 80° C. so as to cover the false bottom with a thin layer. The liquid is withdrawn after having brought the mass in the mash-tun by means of the heater
10 to the temperature of 75° C., 80° C. These solid substances or waste grains remain on the false bottom, and it is in passing through the same, that the liquid undergoes filtration. The first liquid portions which run off from the mash-tun are usually turbid, and they are returned to the mash-tun until the liquid runs off quite clear.

15 The clear liquid is received into the underback whence it is conveyed to the saccharification boiler.

This completes the first steeping operation.

The second steeping or washing of the waste grains obtained from the preceding operation is now proceeded with. For this purpose hot water is introduced into
20 the mash-tun the mixture is raised to a temperature of about 70 to 72° C.; and brewing is again effected with the addition of a tenth of the remaining portion of the milk of malt, the mixture being then allowed to rest during about half an hour. The clear liquid is drawn off as in the first steeping operation and is added to that so drawn off. The residue or spent grains serves for feeding animals.

25 The proportion of hot water used for washing the waste grains is about 2 litres per kilog. of the raw materials employed. The worts passing out of the mash-tun are received into the saccharification boiler which is furnished with a coil for the passage of hot or cold water at will and are raised to a temperature of from about 58° to 60° C. The remainder of the milk of malt is then added, and the
30 mechanical agitator with which the boiler is provided, is made to operate slowly. A temperature of 54—55° C. is maintained and the progress of the saccharification is determined from time to time by means of tincture of iodine and when it is found that the saccharification is complete, the mass is raised to a temperature of from about 62° to 64° C. which is maintained for about 15 to 20 minutes. The worts
35 are then brought to ebullition, and its oxygenation is then proceeded with. The object of maintaining the mass at a temperature of from about 62 to 64° C. during about 15 to 20 minutes is to completely liquefy the starch introduced with the last portion of milk of malt and as at this temperature, the diastase has not lost all its saccharifying power, it can then act effectively upon the starch. The worts having
40 been brought to ebullition, a current of purified air is introduced into the mass by means of an air pump. The air enters through several openings into the bottom of the boiler and in escaping passes through the entire mass in ebullition. The great tendency of the soluble gluten to absorb the oxygen of the air affords the necessary conditions for its slow combustion and, in becoming oxidised, it becomes
45 separated in an insoluble condition.

By the method of manufacture hereinbefore described a brewer will be able to prepare in a methodical manner the worts that are suitable for the kind of beer he wishes to make, according to the respective proportions of maltose and dextrin which he desires to pass into his worts and which determines the nature of the beer
50 produced. For this purpose he has only to suitably vary the duration and the temperatures of the two operations of saccharification in the mash-tun and in the saccharification boiler, and to modify the proportions employed of the milk of green malt. In order to produce beers rich in alcohol, he should particularly favor the production of maltose and he should reserve a larger proportion of milk of malt
55 for saccharification in the boiler; on the contrary when he desires to produce beers rich in extract, he should favor the production of dextrin by operating in the mash-tun at the temperature of 70—72° C., with a larger proportion of milk of malt,

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and, finally the method of high or low fermentation, will serve to complete what he shall have thus prepared.

The two successive operations of saccharification should be effected in the mash-tun by effecting the first pouring of the milk of malt at about 72° C., and after agitating for about half an hour, and allowing to rest for about half an hour, also adding the second pouring at about 58° C., the employment of the saccharification boiler could then be dispensed with, but the brewer would no longer have the same facilities for preparing in a methodical manner the worts suitable for the kind of beer he wishes to obtain.

After the oxygenation in the boiler, the sweetened worts are treated in the ordinary manner of brewing with hops and are brought to the desired degree of concentration according to the kind of beer it is intended to make. The duration of the cooking operation will vary with the degree of concentration to be obtained.

The worts that have been cooked and treated with hops are then rapidly cooled to a temperature suitable for the method of fermentation, high or low, adopted in the establishment in which the process is being carried on. The worts after cooling, are conveyed into the working or fermenting tun wherein they are caused to ferment the ordinary operation of fermentation being followed.

The process hereinbefore described allows of the production of beer under excellent conditions by employing only the raw grain and by causing it to give up all the starch and the other useful substances it contains.

The green malt or germinated barley is employed only for the purpose of providing diastase for use as a saccharizing agent. The proportion of green malt employed is only about 10 % of the weight of the raw grain, thereby diminishing to a very large extent (90 %) the usual operation of malting, and entirely obviating kiln drying of the malt.

The saccharification may also be produced by dry malt, but in this case, the proportion of malt to be employed would be doubled, that is to say it should be in about the proportion of 20 % of the weight of the raw grain as green malt loses by drying, about one half of its active principles.

In the foregoing description raw grain only has been referred to, but it will be obvious that all amylaceous substances, other than barley, such as wheat, rice, maize, potatoes, *etc.* can be utilised in the manner described for the manufacture of beers.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed I declare that what I claim is :—

The hereinabove described improved manufacture of beer by brewing direct from raw grain or amylaceous substance in the manner set forth.

Dated this 28th day of November 1892.

W. LLOYD WISE,
Per F. J. Brougham.